

Photobioreactor for Microalgae Cultivation

Sponsored by the Biological Engineering
Department

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Problem Statement

- ▶ Create an efficient Airlift Photo-Bioreactor to bring biofuel research a step forward at the University of Idaho

Specifications

Constraints

Deliverables

- ▶ Bubble lift Reactor
- ▶ Volume: 10-20 Gallons
- ▶ Maximum Head Space: 1 foot
- ▶ Clearance Between Riser and Base 1.5 inches

- ▶ Portable
- ▶ “Bench Top Model”
- ▶ Easy to see what is happening in the reactor

The background features abstract, overlapping geometric shapes in various shades of green, ranging from light lime to dark forest green. These shapes are primarily located on the left and right sides of the frame, creating a modern, layered effect. The central area is a plain white space.

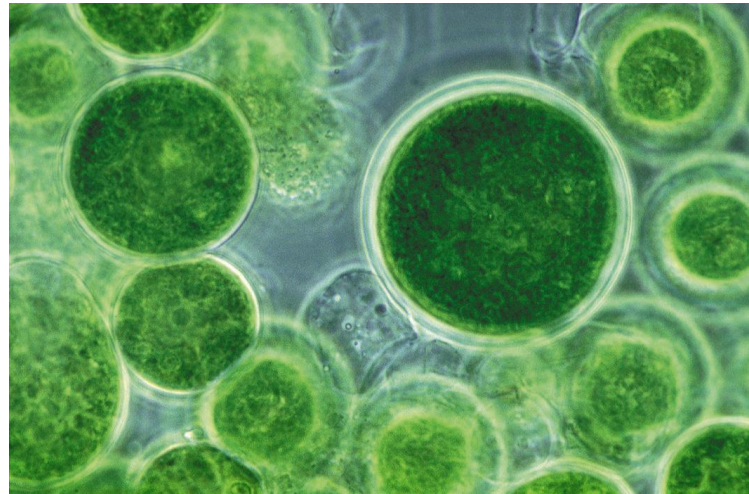
Background

Macroalgae and Microalgae

- ▶ Macroalgae (Seaweed): multicellular organism



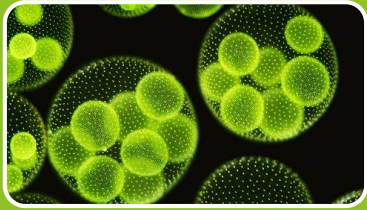
- ▶ Microalgae: unicellular organism



Why microalgae?

- ▶ Fast emerging and promising long-term sustainable source for biomass and oils
 - ▶ i.e. oils for fuel, food, feedstock, and more
- ▶ Algae have evolved to store energy in the form of oil
 - ▶ They do this more efficiently than any other known natural or engineered process

Microalgae benefits



Fast Growth Rates

- Some species exhibit doubling times in the time-frame of hours
- This means quick harvest times



High Biofuel Yields

- Energy stored as oils and carbohydrates
- With their high productivity, large amounts of biofuel can be produced

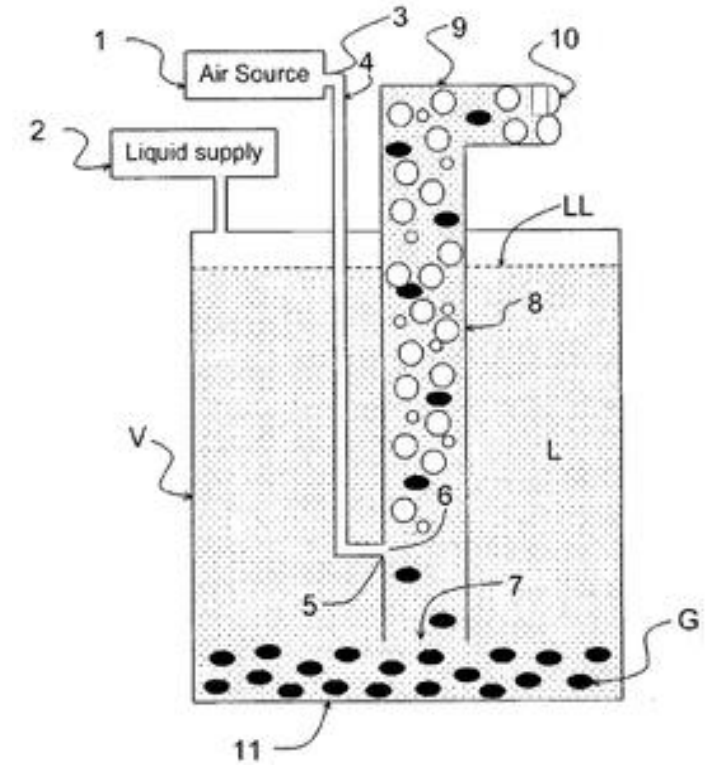


Consume CO₂

- Grow through photosynthesis, thus O₂ is a by-product
- High amounts of CO₂ needed for high production, this can come from powerplant emissions

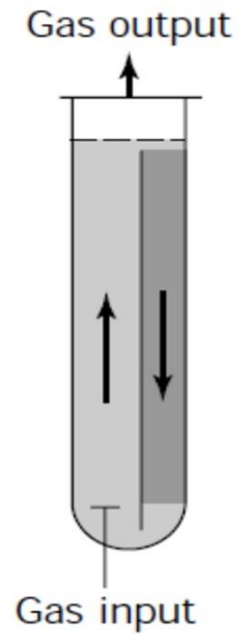
Airlift Principle of Operation

- Requires only compressed gas flow to induce flow.
- No moving parts/ low shear forces
- Functions by a combination of buoyancy and pressure
- Allows us to introduce CO₂ and provide circulation with the same system

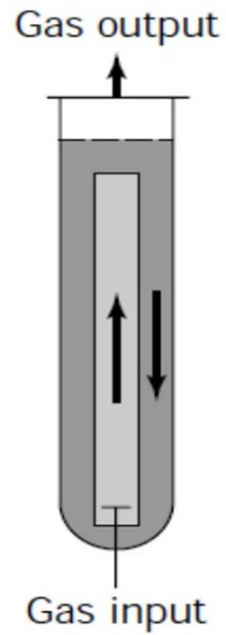


Air Bubble Lift Reactor Types

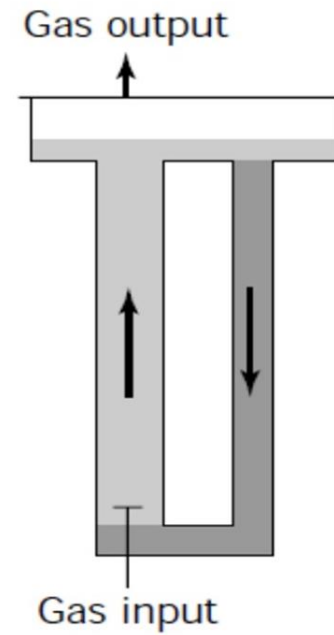
Internal-loop split
ALR



Internal-loop
concentric
tube reactor



External-loop
ALR

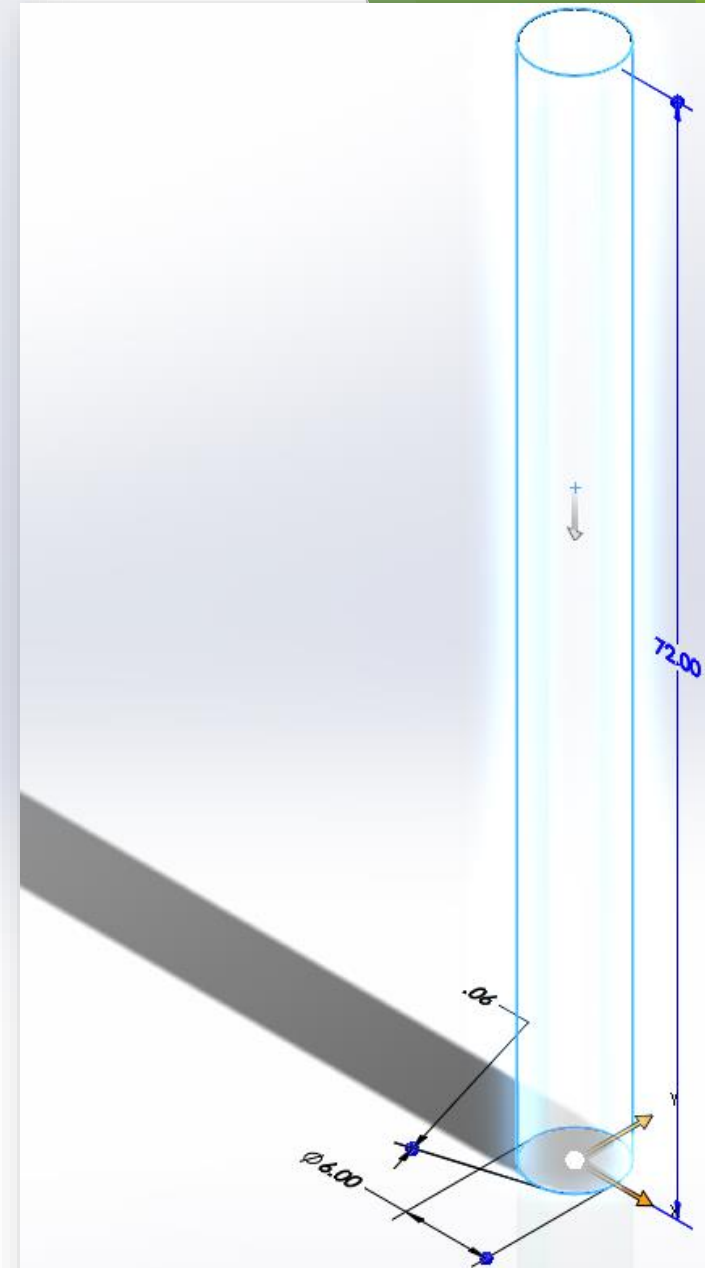
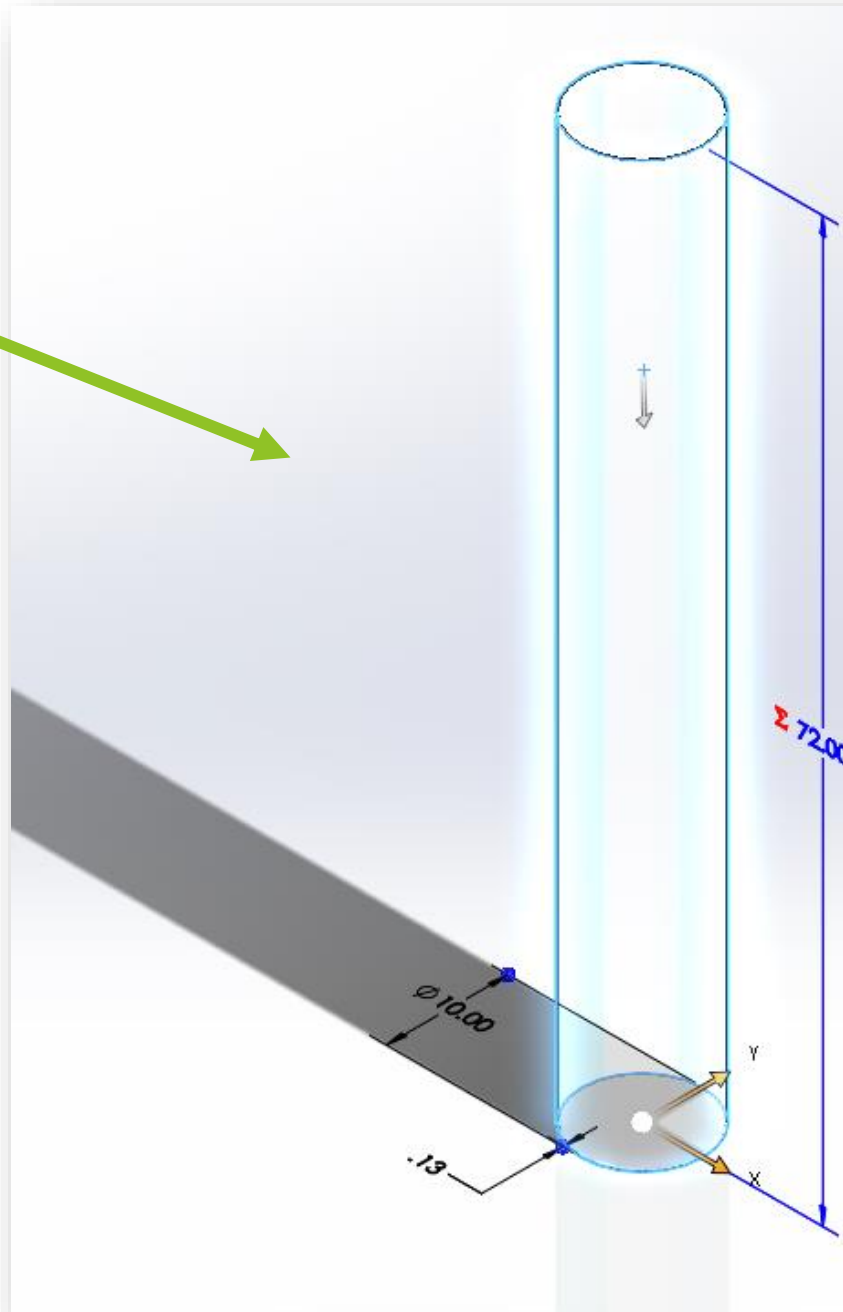


Main Components



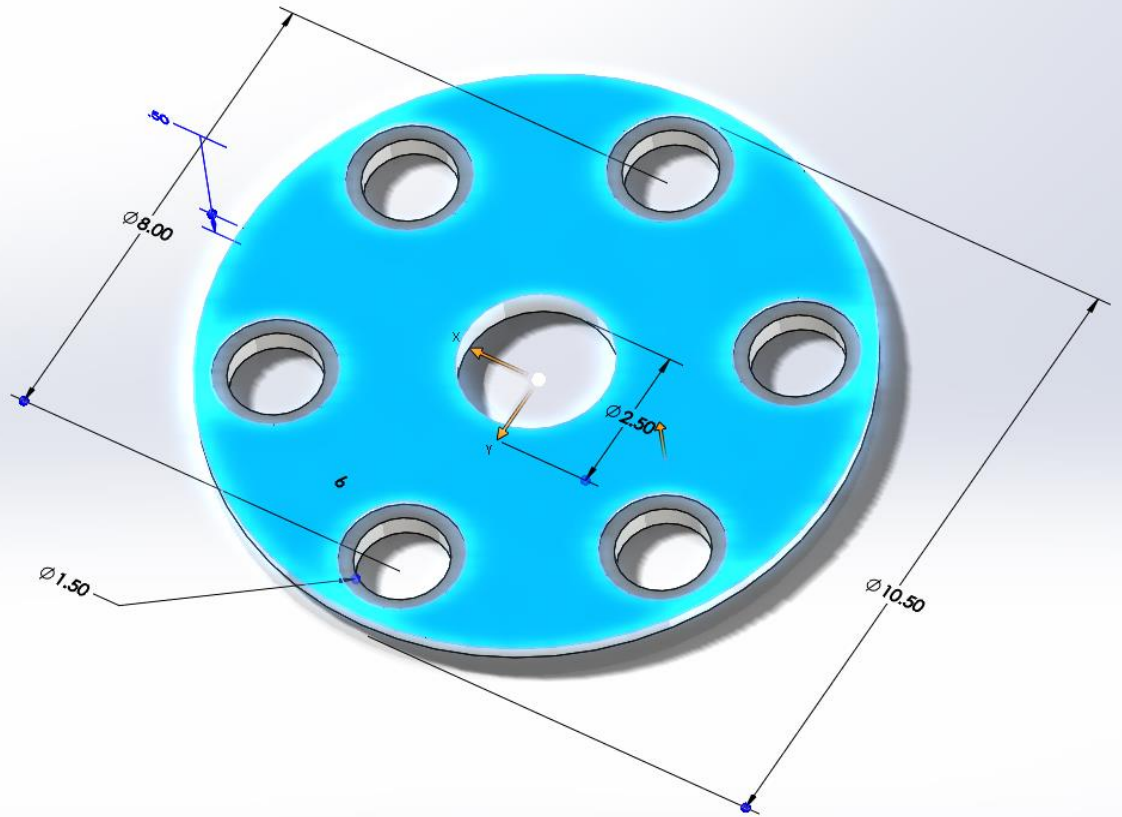
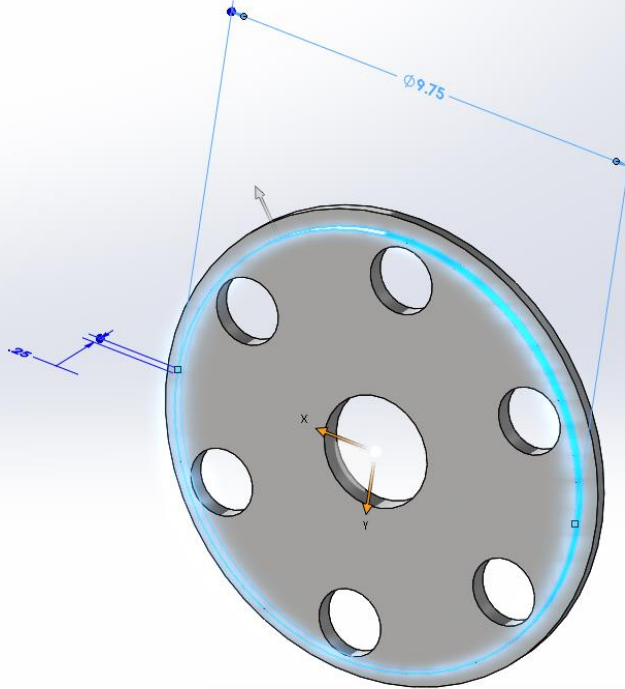
Body

- Main Tube
 - Six Feet tall
 - Ten Inch Diameter
- Riser Tube
 - Five Feet tall
 - 6 Inch Diameter
- 1 foot of headspace



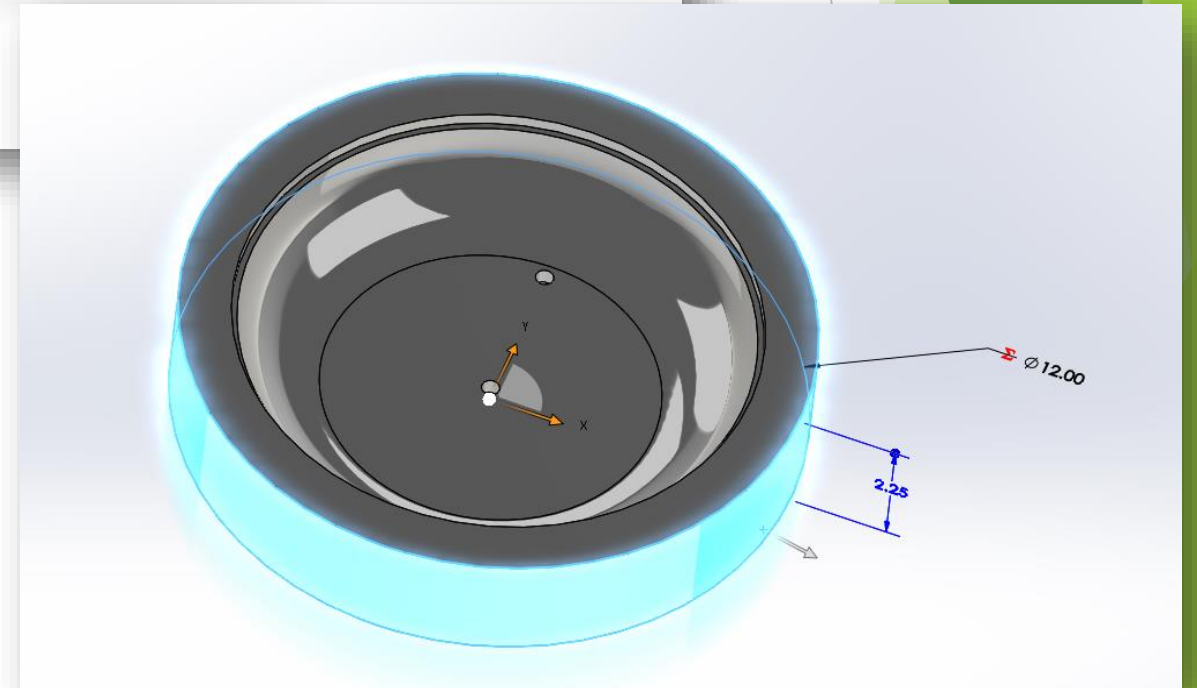
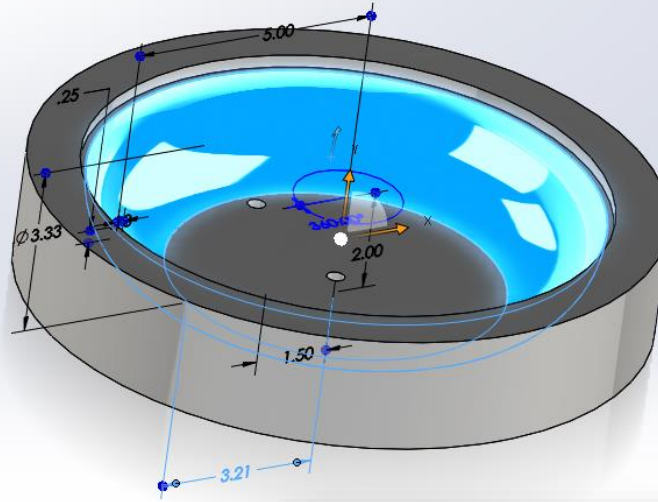
LID

- ▶ Cut Out for Mounting
- ▶ Step Cut Holes for Light Tubes
- ▶ Center Hole for Gas Outlet (or for Plug)
- ▶ Made From Stock in Shop



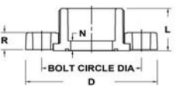
Base

- ▶ Contoured Base to Promote Flow to Riser Tube without Dead Spots
- Drain Plug for Quick Drain
- Will Seal By Being Clamped From Top and Bottom
- Ring Cutout on Top to Center Main Tube
- ▶ Made From Stock in Shop

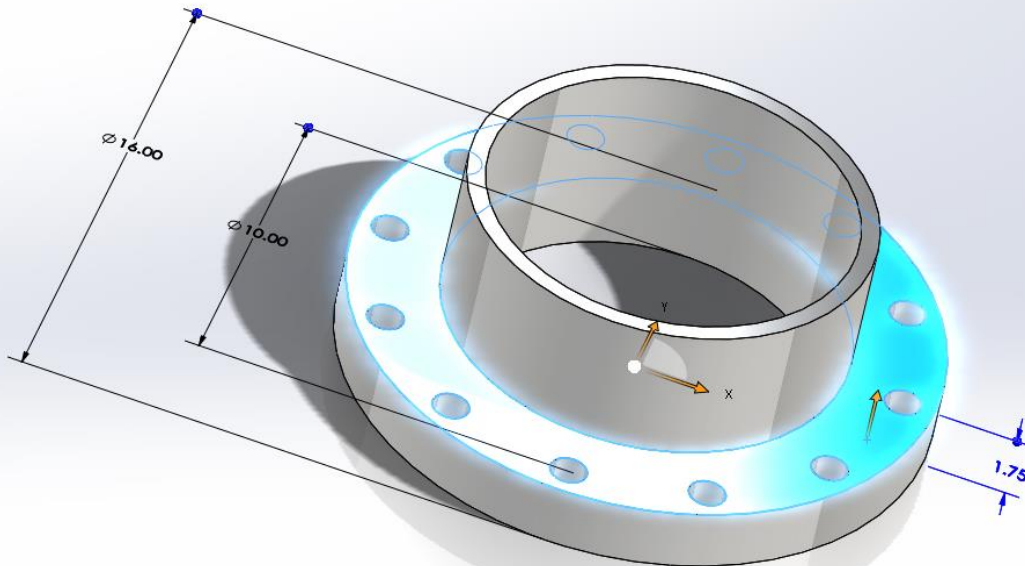


Base

- Heavy Duty Slip on Flange to Take on Support of Reactor
- Gaskets Seal all Cracks



Flange (Loose Ring) -S						
Part No	Size (in)	D	L	N	R	Bolt Circle Dia.
9854-005	½	3 1/2	1 1/32	1/8	9/16	2 3/8
9854-007	¾	3 7/8	1 5/32	1/8	9/16	2 3/4
9854-010	1	4 1/4	1 3/8	1/8	11/16	3 1/8
9854-012	1¼	4 5/8	1 7/16	1/8	11/16	3 1/2
9854-015	1½	5	1 19/32	1/8	3/4	3 7/8
9854-020	2	6	1 3/4	3/16	13/16	4 3/4
9854-025	2½	7	2 1/16	3/16	1	5 1/2
9854-030FT	3	7 5/8	2 1/8	3/16	1 1/16	6
9854-040FT	4	9 3/32	2 1/2	1/4	1 1/4	7 15/32
9854-060FT	6	10 15/16	3 1/4	1/4	1 11/32	9 15/32
9854-080FT	8	13 1/2	4 9/16	5/16	1 1/2	11 3/4
9854-100FT	10	16	5 5/8	1/2	1 3/4	14 1/4
9854-120FT	12	19	6 11/16	9/16	1 3/4	17





Auxiliary Components

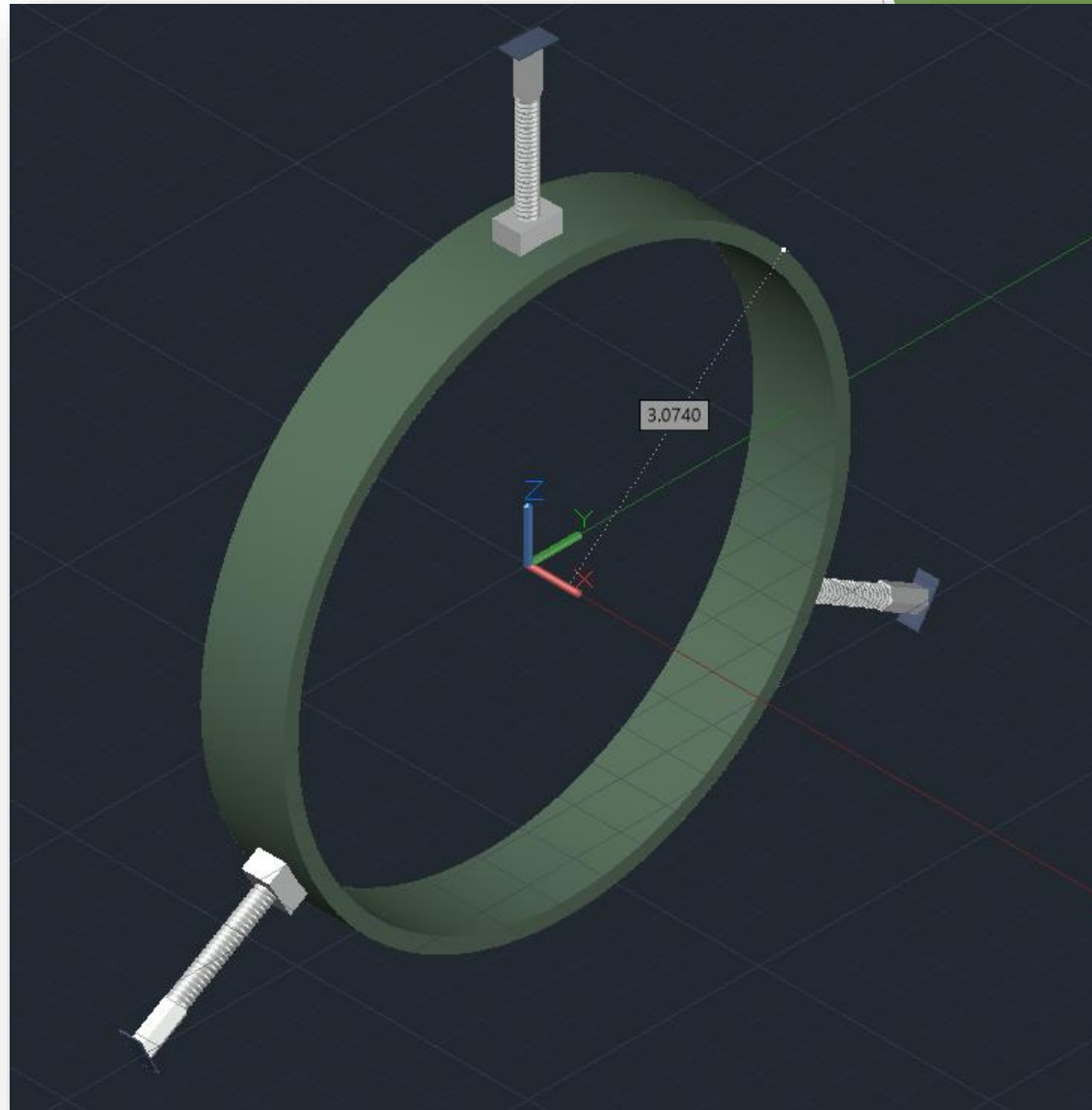
LED LIGHT SYSTEM

- ▶ 6 acrylic tubes
- ▶ 120 watts total power
- ▶ RGB LEDs
- ▶ Controlled with a IR remote
- ▶ Total light spectrum



Body

- ▶ Clamp Connectors Hold Riser Tube to Walls of the Main Tube
- Rubber Ends to Hold it to the Walls
- Threads Allow for Leveling Adjustment
- ▶ Two of them - one near top and one near bottom





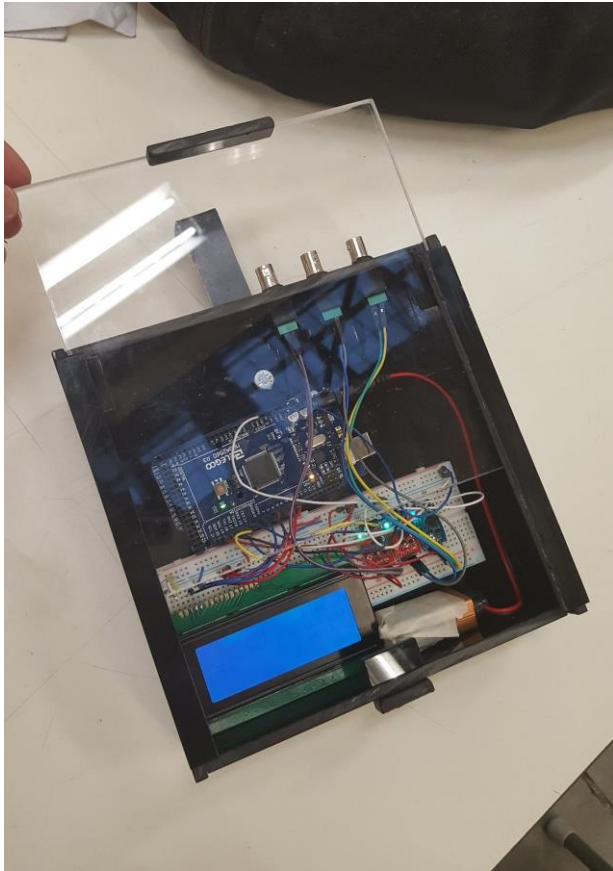


Sensors

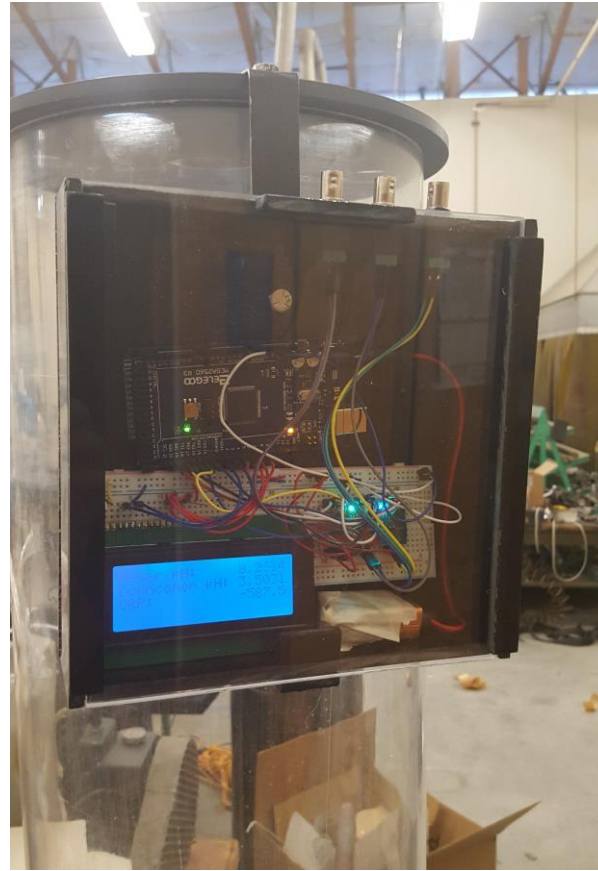
- ▶ Atlas Scientific probes
 - ▶ EZO System
- ▶ Arduino MEGA
- ▶ LCD Readout Display
- ▶ pH in the Downcommer
- ▶ pH in the Riser
- ▶ ORP (Oxidation/Reduction Potential)



Sensor Containment



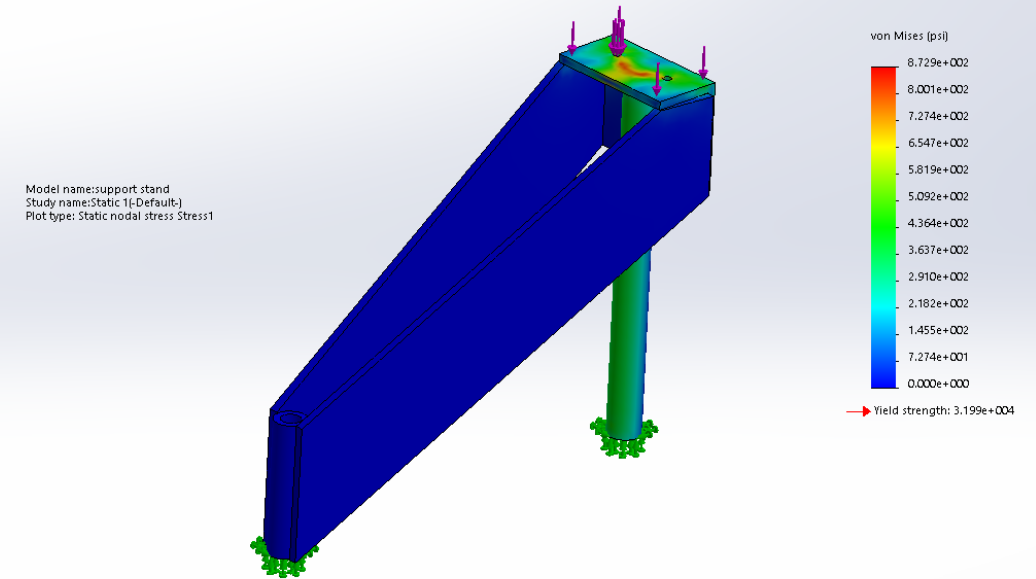
Sliding Clear Lid



Hangs from the
Reactor Lid

Reactor Stand

- Fabricated from welded steel stock
- 3 struts for best stability with minimal weight and material
- Adjustable feet allow for stabilization and leveling.
- FEA Analysis shows a safety factor of 2.7



Questions?

